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Intrusive Gravity Currents in a Stratified Ambient – novel Theoretical Results and Insights

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The intrusion of a fixed volume of “mixed” fluid which is released from a lock (of rectangular or cylindrical shape) and then propagates horizontally at the neutral buoyancy level in a stratified ambient fluid is considered. The density change is linear, in a restricted layer or over the full-depth of the ambient. A closed one-layer shallow-water formulation is used to obtain solutions of the initial-value problem and similarity solutions for the large-time developed motion. The theory is corroborated by numerical Navier–Stokes solutions and comparisons with previous experiments. Novel insights are derived on essential features of the flow-field, in particular: the governing dimensionless parameters, the fact that the initial propagation is with constant speed (for rectangular lock only), the effect of the shape of the lock, the spread with time at some power, the sub-critical (compared to leading linear waves) speed, and the interaction with internal gravity waves.

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